REMARKS

Claims 1-22 are pending in the present application. Claims 1-3, 6, and 7 have been provisionally elected. Claim 1 is independent.

Claim Rejection – 35 U.S.C. 102

Claim 1 has been rejected under 35 U.S.C. 102(b) as being anticipated by Sonehara et al. (U.S. Patent 5,361,151, hereinafter Sonehara). Applicants respectfully traverse this rejection.

Summary of the Present Invention

The present invention in a preferred embodiment relates to a reflective liquid crystal display device. In particular, the reflective liquid crystal display device uses a single polarizer plate for high resolution display that boasts excellent visibility for both black display operation and white display operation. The conditions of the liquid crystal layer of the present invention are such that display produces satisfactory brightness without color defects, by way of a circular polarizing means that passes circularly polarized light in the whole visible wavelength range.

Applicants have determined that black display can be realized upon application of a voltage, only when the circular polarizing means realizes the circularly polarized light in the whole visible wavelength range (Specification, page 41, lines 3-12). The realization of white display requires that the incoming light becomes linearly polarized light in the flat surface of the light reflective means.

In order to produce these conditions for the dark state across the whole visible range, the optical retardation compensator plate 8 needs to provide light in the visible range with a phase difference that is equivalent to a quarter wavelength. The optical retardation compensator plate 9 needs to provide light in the same visible range with a phase difference that is equivalent to half the wavelength. Finally, the configuration of the polarizer plate 10 and the optical retardation compensator plates 8 and 9 is preferably such that light is circularly polarized on the light reflective film 7 while taking birefringence at the optical retardation compensator plates 8 and 9 and the liquid crystal layer 1 into consideration. (Specification, page 41, line 13, to page 43, line 7).

In the normally white state, it is preferable that the twist angle is in a range between 45° and 100°, and that the product of the birefringence difference of the liquid crystal layer and the thickness of the liquid crystal layer is not smaller than 150nm and not greater than 350nm.

By setting the liquid crystal layer based on these conditions, Applicants determined that irrespective of whether the light having wavelengths in the visible area is linearly polarized in directions that vary depending on the wavelengths or linearly polarized light in the same direction irrespective of the wavelengths, a similarly bright state can be achieved. In each case the light is converted from the substantially circularly polarized light in the visible wavelength range entered in the liquid crystal layer. Further, the circularly polarized light of the present invention is not limited to perfectly circularly polarized light satisfying a condition that the ratio of the long axis to short axis

be 1:1, provided that the circular light can be sufficiently blocked by the polarizing plate when the black display is carried out.

Sonehara

Sonehara is directed to a reflection-type liquid crystal display device having a twisted nematic liquid crystal layer. One embodiment allows circularly-polarized incident light to enter and become linearly-polarized light at the reflecting surface (Figure 10, column 6, lines 17-43). In that embodiment, a circular polarizing plate 1006 has a phase plate 1008 (i.e., quarter wavelength) attached to a linear polarizing plate 1007. That embodiment displays a normally white state (i.e., brightness). As can be seen in Figure 12, the display device of Sonehara is based on a single wavelength.

Differences over Sonehara

Claim 1 is directed to a reflective liquid crystal display device based on a liquid crystal layer composed of twist-aligned nematic liquid crystal having positive dielectric anisotrophy. Further the display device includes a circular polarizing means disposed so that a major surface of the circular polarizing means is on a liquid crystal layer side, the circularly polarized light exiting the circular polarizing means through the major surface when natural light enters the circular polarizing means. The circular polarizing means selectively passes either right handed or left handed substantially circularly polarized light in the whole visible wavelength range. In producing a white display, a flat surface of

the light reflective substrate linearly polarizes reflected light in arbitrary directions in a visible wavelength range.

Requirements for Anticipation

> Anticipation is established only when a single prior art reference discloses, expressly or under the principles of inherency, each and every element of a claimed invention as well as disclosing structure which is capable of performing the recited functional limitations. RCA Corp. v. Applied Digital Data Sys., Inc., 730 F.2d 1440, 1444, 221 USPQ 385, 388 (Fed. Cir.); cert. Dismissed, 468 U.S. 1228 (1984); W.L. Gore and Assoc., Inc. v. Garlock, Inc., 721 F.2d 1540, 1554, 220 USPQ 303, 313 (Fed. Cir. 1983), cert. Denied, 469 U.S. 851 (1984).

The Office Action alleges that Figure 10 of Sonehara anticipates the invention of claim 1. Applicants disagree. Sonehara is limited to circularly polarized light having monowavelength, e.g., 550 nm. In other words, only one wavelength will be converted to circularly polarized light. Other wavelengths will not be completely blocked out, resulting in a purplish display when performing a black display. In particular, Figure 11 of Sonehara illustrates an example of data for a black display (curve 1102). The data shows that the reflectivity is low only in the vicinity of 550 nm, thus leading to a purplish display for the black state. In producing the bright state, reflected light is linearly polarized in the same direction (column 1, lines 59-62).

In present claimed invention, on the other hand, the circularly polarized light is passed at the whole wavelength band. Further, the linearly polarized light is arbitrarily directed in the white display state. Thus, Applicants submit

that Sonehara fails to teach or suggest each and every claimed element. Accordingly, Applicants respectfully request that the rejection be withdrawn.

Claim Rejection – 35 U.S.C. 103

Claims 2, 3, 6, and 7 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Sonehara in view of Itoh et al. (U.S. Patent 6,362,862, hereinafter Itoh). Applicants respectfully traverse this rejection.

Itoh is relied on for teaching two compensator plates. However, Itoh fails to make up for the deficiency in Sonehara of circularly polarizing means that passes circularly polarized light in the whole visible wavelength range, and in order to perform a white display, a reflection substrate that reflects light polarized linearly in arbitrary directions in a visible wavelength range. Thus, at least for this reason, all claimed elements are not taught or suggested by Itoh and Sonehara, either alone or in combination. Applicants respectfully submit that the rejection fails to establish *prima facie* obviousness for claims 2, 3, 6, and 7.

CONCLUSION

In view of the above amendments and remarks, reconsideration of the various rejections and allowance of claims 1-3, 6, and 7 is respectfully requested.

Should the Examiner have any questions concerning this application, the Examiner is invited to contact Robert W. Downs (Reg. No. 48,222) at (703) 205-8000 in the Washington, D.C. area.

Pursuant to 37 C.F.R. §§1.17 and 1.136(a), the Applicants respectfully petition for a one (1) month extension for filing a response in connection with the present application and the required fee of $110.00 is attached hereto.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§1.16 or 1.17; particularly, extension of time fees.

Respectfully submitted,

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TCB/RWD/sjl
1248-0467P

Encl.: Marked-up version showing changes made

MARKED-UP VERSION SHOWING CHANGES MADE

IN THE CLAIMS:

The claims have been amended as follows:

1. (Amended) A reflective liquid crystal display device, comprising:

a liquid crystal layer sandwiched between a first substrate having a light reflectibility [reflexibility] and a second substrate having a light transmissibility, the liquid crystal layer being composed of twist-aligned nematic liquid crystal having a positive dielectric anisotropy; and

circular [circularly] polarizing means, including a single linear polarizer plate, for selectively passing either right handed or left handed circularly polarized light out of natural light,

the reflective liquid crystal display device wherein [being characterized in that]

the first substrate, the liquid crystal layer, and the circular [circularly] polarizing means are stacked in this order to form at least a part of the reflective liquid crystal display device,

the circular [circularly] polarizing means is disposed so that a major surface of the circular [circularly] polarizing means is on a liquid crystal layer side, the circularly polarized light exiting the circular [circularly] polarizing means through the major surface when natural light enters the circular [circularly] polarizing means,

the circular polarizing means selectively passes either right handed or left handed substantially circularly polarized light in the whole visible wavelength range from natural light,

to perform the white display, a flat surface of the first substrate linearly polarizes reflected light in arbitrary directions in a visible wavelength range,

the liquid crystal in the liquid crystal layer has a birefringence difference, which, if multiplied by a thickness of the liquid crystal layer, produces a product of not less than 150nm and not more than 350nm, and

the liquid crystal layer has a twist angle in a range of 45° to 100°.

2. (Amended) The reflective liquid crystal display device as set forth in claim 1, wherein [being characterized in that]

the circular [circularly] polarizing means includes: a first optical retardation compensator plate having a retardation in a substrate normal direction set to not less than 100nm and not more than 180nm; a second optical retardation compensator plate having a retardation in a substrate normal direction set to not less than 200nm and not more than 360nm; and a linear polarizer plate, the first optical retardation compensator plate, the second optical retardation compensator plate, and the linear polarizer plate being stacked in this order when viewed from the liquid crystal layer, and

$|2\times\theta 2 - \theta 1|$ has a value not less than 35° and not more than 55°, where $\theta 1$ represents an angle formed by a slow axis of the first optical retardation compensator plate and either a transmission axis or an absorption axis of the

linear polarizer plate, and θ2 represents an angle formed by a slow axis of the second optical retardation compensator plate and either the transmission axis or the absorption axis of the linear polarizer plate.

3. (Amended) The reflective liquid crystal display device as set forth in claim 2, wherein [being characterized in that] the twist angle of the liquid crystal layer is in a range from 60° to 100°,

the product of the birefringence difference of the liquid crystal in the liquid crystal layer and the thickness of the liquid crystal layer is not less than 250nm and not more than 330nm, and

either the transmission axis or the absorption axis of the linear polarizer plate forms an angle, θ3, of not less than 20° and not more than 70°, or not less than 110° and not more than 150° with an alignment direction of the liquid crystal molecules in a close proximity of the second substrate.

6. (Amended) The reflective liquid crystal display device as set forth in any one of claims 1 through 3, [being characterized in that] wherein

a single third optical retardation compensator plate or a plurality of the same is(are) provided between the circular [circularly] polarizing means and the liquid crystal layer to cancel a residual phase difference of the liquid crystal layer.

7. (Amended) The reflective liquid crystal display device as set forth in claim 6, [being characterized in that] wherein

either the third optical retardation compensator plate or at least one of the third optical retardation compensator plates has an inclined optical axis, or a three-dimensionally aligned optical axis having therein a continuously varying inclined direction.